U.S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

SCIENTIFIC NAME: *Popenaias popeii*

COMMON NAME: Texas hornshell

LEAD REGION: Region 2

INFORMATION CURRENT AS OF: April 2010

STATUS/ACTION:

___ Species assessment - determined species did not meet the definition of endangered or threatened under the Act and, therefore, was not elevated to Candidate status

___ New candidate

X Continuing candidate

___ Non-petitioned

X Petitioned - Date petition received: May 11, 2004

__ 90-day positive - FR date:

__ 12-month warranted but precluded - FR date:

__ Did the petition request a reclassification of a listed species?

FOR PETITIONED CANDIDATE SPECIES:

a. Is listing warranted (if yes, see summary of threats below)? Yes

b. To date, has publication of a proposal to list been precluded by other higher priority listing actions? Yes

c. If the answer to a. and b. is "yes", provide an explanation of why the action is precluded.

Higher priority listing actions, including court-approved settlements, court-ordered statutory deadlines for petition findings and listing determinations, emergency listing determinations, and responses to litigation, continue to preclude the proposed and final listing rules for the species. We continue to monitor populations and will change its status or implement an emergency listing if necessary. The "Progress on Revising the Lists" section of the current CNOR (*http://endangered.fws.gov/*) provides information on listing actions taken during the last 12 months.

___ Listing priority change

Former LP: __

New LP: __

Date when the species first became a Candidate (as currently defined): October 2001

___ Candidate removal: Former LP:

___ A – Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.
___U – Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.
___ F – Range is no longer a U.S. territory.
___ I – Insufficient information exists on biological vulnerability and threats to support listing.
___ M – Taxon mistakenly included in past notice of review.
___ N – Taxon does not meet the Act's definition of "species."
___ X – Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Clams, Unionidae

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: New Mexico, Texas; Mexico

CURRENT STATES/ COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: New Mexico (Eddy County), Texas (Brewster, Terrell, Val Verde, and Webb counties); Mexico

LAND OWNERSHIP: Texas hornshell occurs within rivers, which are owned by the States. For the extant population in New Mexico, riparian land ownership along the Black River includes private, State (New Mexico State Land Office), and Federal (Bureau of Land Management) landowners. The populations in Texas, in the Rio Grande near Laredo and within the Rio Grande Wild and Scenic River segment downstream of Big Bend National Park and also in the Devils River are adjacent to private land. However, the Rio Grande Wild and Scenic River is managed and administered by the National Park Service. It is presumed, but not confirmed, that there are additional extant populations within the Big Bend reach of the Rio Grande in Texas, where riparian land ownership includes private, State (Texas Parks and Wildlife Department and Texas General Land Office), and Federal (National Park Service) landowners.

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SUPPORT FIELD OFFICE(S): New Mexico Ecological Services Field Office

BIOLOGICAL INFORMATION:

Species Description: Texas hornshell *(Popenaias popeii)* (Mollusca: Bivalvia) is a member of the freshwater mussel family Unionidae (Murray and Leonard 1962), which is distinguished from other bivalve families by gross shell characteristics including large adult size (>2.34 inches (in.))

(60 millimeters (mm)), elongate shape (shell length greater than height), and soft anatomy (Burch 1973; Lang 2001).

Taxonomy: Texas hornshell was originally described as *Unio popeii* by Lea in 1857, but was later placed in the genus *Elliptio* by Ortmann (1912) and afterward given its own subgenus, within the genus *Elliptio* (Frierson 1927). Subsequently, Heard and Guckert (1970) elevated *Popenaias* to genus status and created a new subfamily, the Popenaiadinae, for the genera *Cyrtonaias* and *Popenaias*. Popenaiadinae was dropped on the basis that its diagnostic criteria represented species-specific rather than phylogenetically significant characters (Heard 1974). Currently, Texas hornshell is classified in the unionid subfamily Ambleminae (Campbell *et al*. 2005; Chapman *et al*. 2008). We have carefully reviewed the available taxonomic information to reach the conclusion that *P. popeii* is a valid taxon.

Life History/Biology: Adult freshwater mussels are filter-feeders, siphoning phytoplankton, diatoms, and other microorganisms from the water column including zooplankton, algae, inorganic material, and organic detritus (James 1987; Smith 2001). For their first several months, juvenile mussels employ foot (pedal) feeding and are thus suspension feeders that feed on algae and detritus. Mussels tend to grow relatively rapidly for the first few years, and then slow appreciably at sexual maturity when energy is being diverted from growth to reproductive activities. Large, heavy-shelled riverine species, like Texas hornshell, tend to have longer life spans, commonly exceeding 20 years. Levine (2009a, p. 23-25 in Lang 2009) has begun to examine age structure in the Black River population of Texas hornshell using data collected since 1997.

Texas hornshell are dioecious (separate sex) mussels. Spawning occurs from January through September in the Black River in New Mexico (Lang 2001; Smith *et al*. 2003). Females produce ova that are held in the gill mantle chamber. Ova are fertilized by sperm, which are released into the water column by males and then taken in through the incurrent siphon of the female. Developing zygotes are held in brood pouches of the gills (marsupia) for four to six weeks (Smith *et al*. 2003).

Female Texas hornshell release larvae, called glochidia, in a sticky mucous mass or string (referred to as conglutinates). Glochidia are obligate parasites on fish and attach to the gills, fins, or head of appropriate host species where they encyst and feed off of the host's body fluids. The New Mexico Department of Game and Fish (NMDGF) is currently investigating ecological hosts for Texas hornshell. In laboratory trials, 24 of 33 native and nonnative fish species infested with Texas hornshell glochidia successfully produced juvenile mussels, indicating that *P. popeii* is a host generalist (Lang 2009, p. 72). However, based on fish surveys of the Black River, 13 fish species from six families (Clupeidae, Cyprinidae, Catostomidae, Ictaluridae, Poecilidae, Centrarchidae) make up the pool of ecologically relevant hosts. Although the taxonomic breadth of fishes serving as hosts for this mussel is promising, two species, gray redhorse (*Moxostoma congestum*) and blue sucker (*Cycleptus elongates*) are State listed as threatened and endangered, respectively (Lang 2009, p. 72; New Mexico Department of Game and Fish 2008). More research is needed to understand whether this is a limiting factor for Texas hornshell.

Glochidia of Texas hornshell metamorphosed into juvenile mussels within 6-10 days post-inoculation on host fish species in lab studies (Gordon *et al*. In Review). Completely metamorphosed juveniles are recruited into the free-living, benthic-dwelling community once released from the host fish (Gordon and Layzer 1989; Howells *et al*. 1996).

Historical Distribution: Texas hornshell is known to have occurred in the lower portion of the Pecos River in New Mexico; in the Rio Grande from San Francisco Creek (in the Big Bend reach, Brewster County) downstream throughout the Lower Rio Grande (Brownsville, Texas), in major tributaries of the Rio Grande in Texas; and southward to the Río Pánuco drainage of San Luis Potosí, México (Metcalf 1982; Taylor 1983; Neck and Metcalf 1988; Howells *et al*. 1996).

In New Mexico, this species was common in the lower Pecos River from North Spring River, Roswell, Chaves County (Cockerell 1902) south to Texas, including the Black and Delaware rivers in Eddy County (Taylor 1983; Carman 2007). Live specimens were taken from the lower Pecos River near Carlsbad, New Mexico, as late as 1937 (Metcalf 1982). Umbonal shell fragments of fossilized Texas hornshell were collected from the Pecos River on the Salt Creek Wilderness of the Bitter Lake National Wildlife Refuge (Chaves County) and the Delaware River (Eddy County) in 1996 (Lang 2001).

Texas historically held an abundant and diverse assemblage of freshwater mussels, with 52 species (of the nearly 300 native taxa in the central U.S.) present in the waters of the State (Howells *et al*. 1996; Howells *et al*. 1997). Dramatic declines have been documented in the past two decades, to a level of such significance that many rivers and streams no longer support any native freshwater mussel populations (Howells *et al*. 1997). Early records show Texas hornshell in the Pecos River, Ward County, Texas (Strecker 1931) and near the Rio Grande confluence in Val Verde County, Texas (Metcalf 1982).

In the Rio Grande in Texas, collections indicate the species occurred historically from San Francisco Creek in the Big Bend area, Brewster County, downstream to Brownsville, near the Gulf of Mexico (Howells *et al*. 1996). Historical collections also confirm the presence of Texas hornshell in the Devils River and Las Moras Creek, tributaries to the Rio Grande in Texas (Howells *et al*. 1996). Live specimens from these areas in Texas were reported by Strecker (1931).

Historic collections in Mexico are from the Rio Salado (type locality) and two disjunct drainages, Ríos Pánuco and Valles (in the state of San Luis Potosí), some 500 miles (mi) (805 kilometers (km)) south of the Rio Grande Basin (Hinkley 1907; Ortmann 1912). Unfortunately, scientific understanding of freshwater mussels located in Mexico is especially poor and aspects of classification, biology, and distribution remain confused. Therefore, the historic distribution of Texas hornshell in Mexico cannot be fully determined.

Current Range: Texas hornshell has declined notably throughout its historic range. The species is confirmed as extant in the Black River in New Mexico and the Devils River and Rio Grande in

Texas (Howells and Ansley 1999; Howells 2001; Howells 2004; Strenth *et al*. 2004; Burlakova and Karatayev 2008; Miller 2008, 2009).

Extant populations of the Texas hornshell in New Mexico are limited to an 8.7 mi (14 km) reach of the Black River (western tributary of the Pecos River) in Eddy County (Lang 2001). The New Mexico population is considered isolated from the Texas populations as they are hydrologically separated by large dams and reservoirs and numerous small diversions.

Texas hornshell is restricted to about 12 percent of its known historic range in New Mexico (Lang 2009, p. 72) and represents the last remaining native mussel in New Mexico, as all other mussels (seven species) considered native in the State have been extirpated (Metcalf 1982, Lang and Mehlhop 1996). Since 1996, a live population of Texas hornshell has been confirmed in the Black River, New Mexico, from Black River Village downstream to the U.S. Highway 285 bridge crossing (Lang 2001). Prior to 1996, live Texas hornshell had not been reported in New Mexico since the 1930s (Metcalf 1982). The population occurs in approximately 8.7 mi (14 km) of the Black River between two low-head dams (Lang 2001). This section of the Black River has permanency of flow, adequate water quality, and suitable substrates that provide habitat conditions for the persistence of this relict population. After examining 10 years of mark-and-recapture data, Levine (2009a, pp. 11-27 in Lang 2009) reported that this population: (1) appeared stable with active recruitment of juvenile mussels into the breeding population; (2) exhibited variable annual growth increments (0.0039 to 0.49 in; 0.1 to 12.4 mm) between years; and (3) showed an inverse relationship between survival and discharge, with survivorship varying from 60 percent to 90 percent among years (Lang 2009, p. 72).

At one monitoring location on the Black River, significant population declines have been observed, and no Texas hornshell have been collected since 2002. The decline is attributed to changes in physical habitats in the river channel caused by large-volume flood events in 2000 that scoured the river bed and eliminated the mussels (Lang 2004). Intensive searches by NMDGF in other portions of the Black River and nearby locations in the Delaware River and Pecos River have not revealed evidence of any additional populations in this region (Lang 2001).

Unionid surveys were initiated in the lower Pecos River in Texas in 1995 and monitoring surveys are ongoing sporadically, but to date have not located any shells of Texas hornshell. Despite numerous collection efforts in the 1990s, no evidence of living freshwater mussels were documented in these areas (Howells 1994, 1996a, 1996b, 1997, 1998, 1999, 2001, 2003, 2004; Howells *et al*. 1996; Howells and Ansley 1999).

In 1998, 32 sites along approximately 100 mi (161 km) of the Rio Grande downstream of Big Bend National Park in Texas and Mexico were surveyed by the Texas Parks and Wildlife Department (TPWD) (Howells and Ansley 1999; Howells 2001). Although no live Texas hornshell were observed, three of five valves collected were of recently dead specimens. In addition, Big Bend National Park began conducting searches for mussels starting in 2005 and has found 48 dead Texas hornshells, many of them recently dead, in the Rio Grande in Big Bend National Park, and in the lower canyons area of the Rio Grande Wild and Scenic River

downstream of the Park (Skiles 2008). This information indicates there are likely extant populations in this reach of the Rio Grande. Extensive collections in the Rio Grande Basin in Texas and in the Rio Conchos Basin in Mexico by TPWD provided no evidence of any other extant populations (Howells 1994, 1995, 1996a, 1996b, 1997, 1998, 1999; Howells *et al*. 1997). However, in March 2008, two live Texas hornshell were discovered in the Devils River and one in the Rio Grande in the Rio Grande Wild and Scenic River segment downstream of Big Bend National Park (Miller 2008; Burlakova and Karatayev 2008).

The distribution of the species in Texas and Mexico was reviewed in Strenth *et al*. (2004). Dead shells of Texas hornshell were recently located in the Rio Sabinas of northern Chihuahua, Mexico; and from two tributaries of the Colorado River in central-west Texas (Llano River, Llano County and South Concho River, Tom Green County). However, since no live speciemens were found, it is unknown whether there are extant populations of Texas hornshell in these locations (Strenth *et al*. 2004).

Habitat: Texas hornshell habitat in the Black River is described as shallow, narrow run stream habitat over limestone conglomerate bedrock where small-grained substrata (clays, silts, sands, and gravel) collect in undercut riverbanks, crevices, shelves, and at the base of large boulders (Lang 2001). These macrohabitat types are most common throughout the middle reach of the Black River from Black River Village downstream to the U.S. Geological Survey gauging station where the river channel is less incised, the riverbanks are not as steep, and the floodway is not as narrow and confined compared to other reaches (Lang 2001). Within this macrohabitat type, Texas hornshell occur singly or aggregated in shallow water microhabitats that serve as "flow refuges" (Strayer 1999) where the mussels can likely secure a foot hold during large volume discharge periods associated with annual precipitation events (Lang 2001).

Population Estimates/Status: There are no available population estimates for Texas hornshell. Extensive mark-recapture surveys are ongoing in the Black River in New Mexico with plans to develop population models to estimate population sizes and environmental variables that influence population dynamics (Berg and Levine 2006a; Lang 2006; Levine 2009a). After examining 10 years of mark-and-recapture data, Levine (2009a, p. 25 in Lang 2009) reported that this population appeared stable with active recruitment of juvenile mussels into the breeding population, but that the overall status of the species is tenuous because it inhabits a substantially reduced range.

THREATS:

A. The present or threatened destruction, modification, or curtailment of its habitat or range. The decline in freshwater mussel populations in New Mexico and Texas, including the Texas hornshell, can be directly attributed to human actions that modify physical conditions in streams, such as dams, water impoundment and diversion, certain flood control practices, water pollution, increased siltation and sedimentation, and climate change. These stressors often result in fundamental changes in the riverine physical environment and water quality that make it

uninhabitable by native mussels and have led to the decline of all freshwater mussels in the Rio Grande basin (Howells 2003).

An example of the decline in mussel populations due to habitat loss is demonstrated at Fort Clark Springs, the headwaters of Las Moras Creek, in Bracketville, Kinney County, Texas (Howells *et al*. 1997). Prior to 1900, the spring had an abundant and diverse community of mussels (over twenty species of mollusks reported), including Texas hornshell (Taylor 1967). Murray (1975) reported the extirpation of the species due to mechanical removal of native vegetation, and conversion of the spring to a swimming pool by paving the banks and chlorinating the water. Examination of the area by TPWD in 1995 found no evidence of any native mussel (Howells *et al*. 1997).

*Water Impoundment***.** Impoundments result in the dramatic modification of riffle and shoal habitats and the resulting loss of mussel resources, especially in larger rivers. Dams interrupt most of a river's ecological processes by modifying flood pulses; controlling impounded water elevations; altering water flow, sediments, nutrients, and energy inputs and outputs; increasing depth; decreasing habitat heterogeneity; and decreasing stability due to subsequent sedimentation (Williams *et al*. 1992; Collier *et al*. 1996).

The reproductive process of riverine mussels is generally disrupted by impoundments making the Texas hornshell unable to successfully reproduce and recruit under reservoir conditions or in tailwater habitats below dams and diversions. In addition, dams can seriously alter downstream water quality and riverine habitat (Collier *et al*. 1996) and negatively impact tailwater mussel populations. These changes include thermal alterations immediately below dams; changes in channel characteristics, habitat availability, and flow regime; daily discharge fluctuations; increased silt loads; altered host fish communities; and blocking migration patterns of host fishes.

Major impoundments within the historic range of Texas hornshell include Brantley Dam in New Mexico and Red Bluff Dam in Texas on the Pecos River and Amistad and Falcon dams in Texas on the Rio Grande. Numerous other smaller impoundments and diversion dams exist within the historic range of the species. Significant mussel populations were lost in the lower Pecos River canyon reaches and lower Devils River of Texas due to inundation by Amistad Reservoir, completed in 1968 (Metcalf 1982; Howells *et al*. 1996; Howells 2001). Falcon Reservoir on the Rio Grande is suspected to have eliminated mussel habitat when it was created in 1953. Construction of McMillan Dam in the early 20th century, replaced by Brantley Dam in 1988, may account for suspected extirpations from the Pecos River near the Seven Rivers confluence, Eddy County, New Mexico.

Water Diversion. Human consumption of river water for agricultural irrigation and municipal use have also contributed to the degraded state of the aquatic ecosystems that no longer support Texas hornshell populations within the species' historic range (Howells 2001). For example, in the upper watershed of the Rio Grande in New Mexico, flows have severely declined, often to the point of ceasing to flow during the irrigation season (Service 2003), resulting in ecological

changes that severely limit native fauna persistence. Although this portion of the Rio Grande is not within the Texas hornshell's historic range, groundwater withdrawals and surface water diversions in this part of the river affect the amount of water that reaches downstream habitats for the species. Metropolitan areas in New Mexico (Santa Fe, Albuquerque, Las Cruces) and El Paso, Texas are in the process of converting their municipal water consumption from diminishing groundwater supplies to diverting surface water from the Rio Grande. It is not clear exactly how Santa Fe and Albuquerque's surface water diversions will affect instream flows because much of the surface water that will be used is "San Juan Chama" water diverted from an entirely different watershed into the Rio Grande basin for this purpose. Thus, the switch from groundwater pumping to surface water diversion for municipal uses in these cities may actually result in more water in the Rio Grande as the intensity of groundwater pumping adjacent to the river diminishes. However, increased surface water diversions for municipal use in Las Cruces, New Mexico, and El Paso, Texas will likely lead to less water for instream flows in the Rio Grande below El Paso, within the range of Texas hornshell.

Alterations to Channel Morphology. The channel morphology and flow regimes of the Rio Grande and Pecos River have been severely modified over the past century for flood control, water supply, and border maintenance through channelization, levee construction, destruction of native riparian vegetation, dredging, water diversion, and groundwater pumping (Howells 2001; Carman 2007). The invasion of the exotic riparian salt cedar tree (*Tamarisk* sp.), along with levees, have fortified the river banks. Flood control dams upstream have curtailed the annual peak flows and resulted in sediment rich, narrow river channels that no longer interact with the floodplain and do not provide natural riverine processes to support native biotic communities, including mussels (Layzer *et al*. 1993) such as the Texas hornshell.

Water Quality. The release of pollutants into streams from point and non-point sources have immediate impacts on water quality conditions and may make environments unsuitable for habitation by mussels. In addition, regional groundwater depletion can cause losses in stream flows that result in higher concentrations of pollutants, and pollution can also arise from groundwater contaminants (Hennighausen 1969; Metcalf 1982; Quarles 1983; Taylor 1983; NMDGF 1988; Williams *et al*. 1993; Neves *et al*. 1997). Much of the riverine habitat within the historic range of Texas hornshell has experienced tremendous increases in salinity levels as a result of agricultural returns to the rivers (Howells 2001). Studies indicate that Texas hornshell show behavioral signs of physiological stress, followed by death, at a salinity of 7.0 parts per thousand (ppt)(Lang 2001). Within the occupied area of the Black River, salinity is about 0.9 ppt, but increases significantly downstream of the Carlsbad Irrigation District Dam to 2.8 ppt (Lang 2001). Additionally, salinity levels in the Pecos River downstream of the Black River confluence range from 6.0-7.0 ppt (Lang 2001).

Oil and gas industry operations (exploration, transfer, storage, and refining) are ongoing in the Black River sub-basin and lower Pecos River valley of New Mexico and Texas. Such extractive activities are known to contaminate ground- and surface-waters (Jercinovic 1982, 1984; Longmire 1983; Boyer 1986; Rail 1989; Martinez *et al*. 1998) and represent a current threat to extant Texas hornshell populations (Eisler 1987; Havlik and Marking 1987; Green and Trett

1989; Neves *et al*. 1997). Contaminants contained in point and non-point discharges can degrade water and substrate quality and adversely impact mussel populations. The effects are especially profound on juvenile mussels, which can readily ingest common contaminants such as ammonia and chlorine. Glochidia also appear to be very sensitive to certain toxicants, such as heavy metals. Even at low levels, certain heavy metals such as Copper, may inhibit glochidial attachment to fish hosts (Havlik and Marking 1987).

Increased siltation and sedimentation. Siltation and general sedimentation runoff have been implicated in the decline of stream mussel populations across the United States (Lang 2009, p. 74). Scouring in upstream areas often results in excessive deposition of silt downstream, inundating larger substrates and eliminating mussel habitats. Sources of silt and sediment include overgrazing, which began in the mid-1800s; removal of terrestrial plants and replacement with nonnative vegetation; complete clearing of riparian vegetation for agricultural, silvicultural, or other purposes; poorly designed and executed highways and bridges; and construction, mining, and other practices that allow exposed earth to enter streams (Howells 2001). Specific impacts on mussels from silt and sediments include clogged gills, which reduce feeding and respiratory efficiency, impair reproductive activity, disrupt metabolic processes, and reduce growth rates. Silt can also increase substrate instability and physically smother mussels (Houp 1993).

Cumulative impacts of certain land-use practices (e.g., removal of native vegetation; prolonged overgrazing; non-point source runoff pollution of sediments, toxic chemicals, and hydrocarbons) within the watershed of the Black River have increased erosion and sedimentation in the river, exacerbated drainage basin entrenchment, increased pulse-discharge of pollutants into the system, and altered stream channel morphology and substrate composition (Lang 2001). These environmental changes have profound effects on the long-term viability of mollusk populations, overall health of aquatic ecosystems, and stability of low flow refuge habitat typically colonized by Texas hornshell (Fuller 1974; Neves *et al*. 1997; Strayer 1999; Carman 2007). Although the Black River and other streams within the Texas hornshell's historic range have probably always experienced flooding, pulse discharges may be larger in volume now due to the removal of native vegetation within the watersheds (Lang 2009, p. 73). Pulse discharge of large-volume storm flows in the Black River represent a primary cause of natural mortality of localized populations of Texas hornshell (Lang 2006) because they scour streambeds and appear to dislodge Texas hornshell from their habitats (Levine 2009a, p. 22 in Lang 2009).

Climate Change. Climate change could be another cause of threats to water quantity and habitat maintenance for this aquatic species. The potential effects of future climate change could reduce overall water availability in New Mexico, Texas, and northern Mexico and compound the threat of declining flows. Modeling efforts evaluating climate change in Texas have only recently been initiated (for example, CH2M HILL 2008; Jackson 2008; Mace and Wade 2008). As with many areas of North America, the range of the Texas hornshell is projected to experience an overall warming trend over the next 50 to 100 years (Texas Water Development Board 2008). Although precipitation models vary substantially, with some even predicting increased precipitation annually, a consensus is emerging that evaporation rates are likely to increase significantly (Jackson 2008; CH2M HILL 2008). Many models are also predicting that seasonal variability in

flow rates is likely to increase with more precipitation occurring in the wet seasons and more extended dry periods (CH2M HILL 2008, Jackson 2008, Mace and Wade 2008). A greater likelihood for more extreme droughts was identified as a potential impact to water resources (CH2M HILL 2008).

All climate change modeling has inherent uncertainties due to the incorporation of many variables that are difficult to accurately predict (Texas Water Development Board 2008, Jackson 2008). As a result, it is unknown how much effect future climate change may have on the aquatic resources that serve as habitat for the Texas hornshell. If climate trends result in increased drought, then it could exacerbate declining flows for the hornshell.

Based on our evaluation of Factor A (i.e., current riverine conditions, pollution by point and non-point source contaminants, changes in channel morphology and flow regimes, oil and gas activities, ongoing groundwater pumping for municipalities, and climate change), we conclude that the Texas hornshell is threatened by present and potential destruction, modification, or curtailment of its habitat and range.

B. Overutilization for commercial, recreational, scientific, or educational purposes.
Texas hornshell is not a commercially valuable species, but may be increasingly sought by collectors due to its rarity. This species inhabits relatively small stream lengths in the Black River in New Mexico and the Rio Grande and Devils River in Texas, and its populations are small. Although scientific collecting is not thought to represent a significant threat, localized populations could be impacted by over collecting in the future. However, based on our evaluation of Factor B, the Texas hornshell is not currently threatened by overutilization for commercial, recreational, scientific, or educational purposes.

C. Disease or predation.
The occurrence of disease in mussels is virtually unknown and little is known about predation on the Texas hornshell. Muskrats are known to prey upon live Texas hornshell, as evidenced by freshly fragmented valves strewn along vegetated riverbank margins (Lang 2001). Dragonfly nymphs (Anisoptera) have also been observed to prey on the gills of living Texas hornshell (Levine *et al*. 2009, p. 65-68 in Lang 2009). However, the overall impact of disease and predation on Texas hornshell populations have is unknown.

D. The inadequacy of existing regulatory mechanisms.
Under the Wildlife Conservation Act, the State of New Mexico has listed the Texas hornshell as an endangered species since 1983 (New Mexico Department of Game and Fish 2008). Protection under New Mexico's Wildlife Conservation Act is limited to "take" (harass, hunt, capture, or kill any wildlife, or attempt to do so), with no regulatory protection of occupied or potential habitats. The recovery plan for Texas hornshell issued by the State of New Mexico (Carman 2007) does not provide any additional regulatory mechanisms, but is expected to improve the status of the species as it is implemented. Additionally, Texas hornshell is considered a Species of Greatest Conservation Need in the New Mexico Comprehensive Wildlife Conservation Strategy (NMDGF 2006).

The Texas hornshell is a candidate for listing as threatened by the State of Texas. Texas only requires a fishing license for collection of mussels and a special permit for commercial collections. Texas has established 28 no-harvest mussel sanctuaries throughout the State (Howells *et al*. 1997). However, none occur within the Rio Grande or Pecos river basins. In December 2008, the Service designated a 10(j) nonessential experimental population area for the Rio Grande silvery minnow in the Big Bend area of Texas. Because the Rio Grande silvery minnow will be treated as a threatened species within Big Bend National Park and the Rio Grande Wild and Scenic River and will thus receive some protections under section 7 of the Endangered Species Act, this may provide some "tangential" regulatory protection for Texas hornshell where it shares riverine habitat with the minnow. There are no other listed fish species in this section of the Rio Grande.

Based on our evaluation of Factor D, we conclude that protections from the existing regulatory mechanisms are not adequate to limit or alleviate the threats to the species.

E. Other natural or manmade factors affecting its continued existence.
Exotic and Invasive Species. Introduction of exotic bivalves, namely the Asian clam (*Corbicula fluminea*), quagga mussel (*Dreissena bugensis*), and zebra mussel (*D. polymorpha*), to surface waters of New Mexico and Texas could threaten extant Texas hornshell populations through potential competitive exclusion for space and resources (Williams *et al*. 1993; Neves *et al*. 1997). Of these, only the Asian clam is known to already be present in many locations within the historic range of Texas hornshell (Howells 1999). However, there is little evidence that this particular nonnative can cause changes in native mussel populations (Strayer 1999). Therefore, we cannot conclude that this nonnative species is currently a threat to Texas hornshell.

Water soluble toxins produced by the invasive golden alga, *Pyrmnesuim parvum,* are highly toxic to gillbreathing aquatic fauna such as crustaceans, mollusks (mussels, snails), fish, and larval stages of amphibians (Paster 1973 in Lang 2009, p. 78). Recent fish kills (2002-2005) attributed to golden alga were reported in the lower Pecos River from Brantley Reservoir downstream to the Black River confluence near Malaga, New Mexico (Lang 2009, p. 78). Although there are no known instances of surface water contamination by golden alga toxins in the Black River or the Rio Grande where the Texas hornshell occurs, such a phenomenon represents a potential threat to this species.

Availability of fish hosts. Additionally, a critical component of the life history of freshwater mussels is the availability of fish hosts for developing glochidia. The fish communities of the rivers and streams within the historic range of Texas hornshell have been drastically altered, primarily by changes in habitat conditions (Treviño-Robinson 1959; Smith and Miller 1986; Miller *et al*. 1989; Hubbs 1990; Edwards *et al*. 1991). Over the last century, the decline of many native fishes, and even the extinction and extirpation of some species, could indirectly have affected mussel populations through the loss of necessary hosts to complete the mussel reproductive cycle and loss of ecological hosts may represent a potential threat to the Texas hornshell (Levine 2009b, p. 43 in Lang 2009). However, recent research (Levine 2009b in Lang

2009, p. 72) shows that the Texas hornshell probably utilizes a broad range of host species, so it is unlikely that this is a significant threat to the species.

Based on our evaluation of Factor E, the Texas hornshell is not believed to be threatened by other natural or manmade factors (e.g., competition with nonnatives or the declining availability of fish hosts necessary for completing the life cycle of Texas hornshell).

CONSERVATION MEASURES PLANNED OR IMPLEMENTED: Texas hornshell is listed as endangered in New Mexico and is a high priority species in the Wildlife Action Plans of New Mexico and Texas (TPWD 2005; NMDGF 2006).

NMDGF has ongoing studies in the Black River for Texas hornshell, including determination of ecological fish hosts, observing life history parameters, survivability of juveniles, monitoring habitat, and analyzing population dynamics (Lang 2006, Lang 2009). Dr. Randy Hoeh, from Kent State University, has an ongoing genetic study for Texas hornshell comparing allozyme and mtDNA for the New Mexico population and has been sent tissue samples from the recently discovered extant specimens in Texas (Lang 2008). Data collected and analyzed thus far are consistent with populations of the species from New Mexico and Texas being conspecific (i.e., members of one species)(Hoeh 2009, p. 72 in Lang 2009).

NMDGF has formed a State recovery team for this species and completed the Texas Hornshell Recovery Plan (Recovery Plan) for the population in New Mexico in August 2007 (Carman 2007). The Recovery Plan provides information about necessary conservation efforts to remove the need to list the species in New Mexico. The Recovery Plan does not include populations outside of New Mexico. NMDGF is leading the following ongoing efforts related to implementation of the Recovery Plan including, but not limited to:

- Development of a Candidate Conservation Agreement with Assurances with private landowners (a final draft is being reviewed by the Service);
- Working with New Mexico Environment Department to strengthen water quality requirements in the Black River and nominate it for Outstanding National Resource Water;
- Funding (along with the Natural Resources Conservation Service) private landowners for habitat protection. NMDGF has contracts with three New Mexico landowners to fence lands to prevent illegal trespass and dumping, which introduces toxic substances into the river;
- Funding the Albuquerque BioPark for captive rearing investigations for Texas hornshell. Appropriate habitat in the captive containers has been established and hornshells were taken from the wild and placed in the habitats in the summer of 2008;
- Continuing research on host fish relationships;
- Genetics research on the species (Carman 2008).

Big Bend National Park began conducting searches for mussels starting in 2005 and plans to continue searches as funding allows in the Rio Grande in Big Bend National Park and in the lower canyons area of the Rio Grande Wild and Scenic River downstream of the Park (Skiles 2008). In addition, TPWD has established a volunteer mussel watch program for interested individuals to report mussel shell collections and monitor some known populations in the State of Texas.

The Service is currently placing new focus on the aquatic conservation of the Big Bend reach of the Rio Grande due to our efforts to reestablish the Rio Grande silvery minnow there. We are working on forming a collaborative group with our Federal, State, private, and nongovernmental partners in Texas to plan and accomplish riparian and aquatic ecosystem restoration projects. This effort will result in additional conservation measures for the river that could benefit Texas hornshell.

SUMMARY OF THREATS: The primary threats to the Texas hornshell are habitat alterations such as stream bank channelization, impoundments, and diversions for agriculture and flood control; contamination of water from the oil and gas industry; alterations in the natural riverine hydrology; increased sedimentation from prolonged overgrazing and loss of native vegetation; and climate change.

We find that the Texas hornshell is warranted for listing throughout its range, and, therefore, find that it is unnecessary to analyze whether it is threatened or endangered in a significant portion of its range.

RECOMMENDED CONSERVATION MEASURES: Long-term conservation measures are needed to facilitate and accomplish cooperative efforts between resource management agencies and private land owners in both New Mexico and Texas. Implementation of the recovery plan and completion of a CCAA with interested private landowners could further the conservation of this species in New Mexico. Development of Best Management Practices for the Black River watershed is recommended by a proactive consortium of diverse land-use interests, led by NMDGF, whose primary objective is to protect the long-term sustainability (ecology and economy) of the region. A similar planning and implementation process needs to be initiated for the populations in Texas.

NMDGF assessed riverine conditions within the historic range and has concluded that relocation of Texas hornshell to other native habitat in New Mexico is not advisable (Lang 2004). This conclusion is because the hydrochemical conditions in the lower Pecos River (below Brantley Reservoir) were found unsuitable and the riverine substrates in the upper Pecos River (above Brantley Reservoir) consist primarily of shifting sands, which are not conducive for mussel habitat. However, the Rio Grande and the Devils River in Texas should be investigated as potential areas for relocation or augmentation of the populations there.

Continuing monitoring efforts are needed throughout former and occupied sites in Texas to better define the species' distribution and status in the Big Bend region on the Rio Grande, the Devils

River, and in the Llano and South Concho rivers of central Texas. Updated status information is needed for the Texas hornshell population in the Rio Grande near Laredo, Texas.

The Service should consider pursuing Candidate Conservation Agreements with interested parties for Texas hornshell populations in Texas.

LISTING PRIORITY:

THREAT			
Magnitude	Immediacy	Taxonomy	Priority
High	Imminent	Monotypic genus	1
		Species	2
		Subspecies/population	3
	Non-imminent	Monotypic genus	4
		Species	5
		Subspecies/population	6
Moderate to Low	**Imminent**	Monotypic genus	7
		Species	**8***
		Subspecies/population	9
	Non-imminent	Monotypic genus	10
		Species	11
		Subspecies/population	12

Rationale for listing priority number:

Magnitude: Until March 2008, the only known extant populations of Texas hornshell were in New Mexico's Black River and the Rio Grande near Laredo, Texas. However, in March 2008, two previously unknown localities were confirmed in Texas – one in the Devils River and one in the mainstem Rio Grande within the Rio Grande Wild and Scenic River segment downstream of Big Bend National Park. The primary threats to this species are habitat alterations such as stream bank channelization, impoundments, and diversions for agriculture and flood control; contamination of water by the oil and gas industry; alterations in the natural riverine hydrology; and increased sedimentation from prolonged overgrazing and loss of native vegetation. Although riverine habitats throughout the species' known occupied range are under constant threat from these ongoing or potential activities, numerous conservation actions to benefit the species are underway in New Mexico, including the completion of a State recovery plan for the species and the drafting of a Candidate Conservation Agreement with Assurances, and are beginning in Texas. Accordingly, we find the overall magnitude of threats is moderate.

Imminence: Past riverine habitat alterations have already occurred and resulted in the much reduced distribution of this species. Demands for water from the Rio Grande and Pecos river basins are ongoing and continue to increase and make future habitat degradation likely. Therefore, we find the immediacy of threats to be imminent.

Yes Have you promptly reviewed all of the information received regarding the species for the purpose of determining whether emergency listing is needed?

Is Emergency Listing Warranted? No. Confirmed populations of Texas hornshell exist in a limited portion of the species' historic range and are threatened with extinction; however, there are no immediate increases in threats likely to result in immediate extinction. Recent surveys have discovered new live specimens in Texas and the Black River population appears to be stable. NMDGF completed a State recovery plan for the species in 2007. The Service is currently placing new focus on aquatic species and habitat conservation in the Big Bend reach of the Rio Grande due to our efforts to reestablish the endangered Rio Grande silvery minnow. This will result in additional conservation measures for the river that could benefit Texas hornshell.

DESCRIPTION OF MONITORING: NMDGF has conducted extensive studies of the Texas hornshell populations and habitats in the Black River since 1997 and plan on continuing this activity (Lang 2006; Carman 2008). Mark and recapture studies began in 1997, and are continuing, in order to document population changes in occupied habitat in New Mexico (Lang 2001, 2005, 2006; Berg and Levine 2006a).

Long-time mussel biologist for TPWD, Dr. Robert G. Howells, has retired and his responsibilities to survey and monitor mussel populations in the State have not been continued by TPWD. However, Tom Miller (2008) from Laredo State University has been conducting mussel surveys in the Rio Grande basin in Texas for several years, resulting in the recent discovery of live specimens of the species in two new locations in Texas. Additionally, Big Bend National Park has been conducting mussel bank surveys and found a significant number of recently dead Texas hornshell in the lower canyons area downstream of Big Bend National Park in February 2008 (Skiles 2008, 2009). Burlakova and Karatayev (2008) have also been surveying mussels in Texas in the Rio Grande and Concho River basins. These recent discoveries will likely lead to increased survey and monitoring efforts in Texas (Miller 2008).

COORDINATION WITH STATES
Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment:

In February 2010, the Service contacted the New Mexico Department of Game and Fish, the Texas Parks and Wildlife Department, Big Bend National Park, and independent researchers who had previously provided information about the Texas hornshell. In response, Lyobov Burlakova of Buffalo State College in New York, Brian Lang from the New Mexico Department of Game and Fish, and Raymond Skiles from Big Bend National Park all provided information and/or comments, which are included in this form. The Service contacted TPWD by email on March 4, 2010, requesting any new information on candidate species in Texas. TPWD provided an email response dated March 30, 2010, and provided no new information on this species (Wendy Gordon, TPWD, pers. comm., 2010).

Indicate which State(s) did not provide any information or comments: NA

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APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve: _____ May 21, 2010

Acting Regional Director, Fish and Wildlife Service Date

Concur: _____ ACTING Director, Fish and Wildlife Service Date: October 22, 2010

Do not concur: _____ _____

Director, Fish and Wildlife Service Date

Director's Remarks:

Date of annual review: April 2010
Conducted by: Aimee Roberson